A Proposal for:

EVALUATION OF ORGANIC MATTER ADDITION AND INCORPORATION ON STEEP CUT SLOPES

Phase II: Test Plot Construction and Performance Monitoring

Submitted To:

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1.0 Problem Statement

Fundamental to successful revegetation of highway corridors following disturbance is the creation of a growth environment conducive to the establishment and early survival of the seeded plants. Steep cut slopes present a unique problem. The steepness of cut slopes prevents practical replacement of salvaged topsoil with conventional equipment. The current remedy is simply to broadcast seed and hydromulch the bare slope. These techniques all too often result in marginal plant establishment since germination and initial seedling survival is limited by nutrient poor, rocky substrates characteristic of cut slopes. The resulting poor vegetation establishment leads to increased erosion and sedimentation, occasional slope failure, increased noxious weed growth, and low aesthetic quality. All of these factors except the latter can be expected to substantially increase maintenance costs in the affected areas.

Several types of geologic parent material have been identified in Montana that causes recurrent maintenance problems for MDT when encountered on steep cut slopes. Alluvial rock, glacial till and marine shale are exposed in road cuts in many areas within the State. Glacial till and alluvial rock are common in western Montana while marine shale is common in eastern Montana. In all three cases limited vegetation has developed following seeding into nutrient poor parent material. Significant erosion has resulted, especially from the glacial till and marine shale deposits. Roadside ditches have become clogged with eroded sediment leading to increased maintenance costs and long-term concern for road base stability. Road base aggregate can become saturated as drainage ditches fail to operate properly leading to frost heaving of bituminous overlays.

Amendment of steep cut slopes with organic matter may lead to improved vegetation condition, decreased erosion and reduced maintenance cost.

2.0 Background Summary

The benefits of soil organic matter are widely known and have been shown to produce significant positive responses in vegetation performance when applied both as surface top dressing and shallow incorporation into the substrate profile. Organic matter is a critically important attribute of the soil environment, contributing or responsible for enhanced water infiltration, nutrient availability, water holding capacity, mycorrhizae development, and improved soil structure.

Departments of Transportation across the country have encountered similar problems to those faced in Montana. Accelerated erosion and poor vegetation establishment are recurrent problems on a number of different geologic substrates including weathered granite, bentonite and volcanic ash. Addition of compost has been successfully employed in several States to mitigate steep slope erosion problems along highway corridors. Significant and relevant research investigations have been conducted in California, Connecticut, Idaho, Iowa and Texas that demonstrate the effectiveness of compost addition. These core DOT findings are summarized in the Phase I Report, and show that compost addition is an effective, permanent solution to controlling erosion on steep cut slopes.

Amendment of poor soils with compost has been accomplished in a diversity of geologic and climatologic settings across the U.S. as reported in the Phase I Literature Review. Compost has been demonstrated effective in reducing sediment yield from steep slopes, decreasing runoff volume, improving runoff water quality and enhancing vegetation establishment. From these literature sources, application of compost has nearly always occurred as a blanket

3.0 Objectives

The overall research objectives for the project are to:

? Reduce sediment yield and erosion from steep highway cut slopes through amendment with compost;

? Enhance vegetation establishment on steep highway cut slopes through amendment with compost;

? Develop amendment rates, application protocols and techniques for compost addition on steep highway cut slopes;

? Implement, monitor and evaluate test plots on steep highway cut slopes; and

? Communicate, report and provide technology transfer of the research findings.

Phase I of this project has been completed. The objectives of Phase I included:

? conducting a review of relevant scientific literature with respect to organic matter amendment addition to enhance plant growth media, and an assessment of their applicability to conditions in Montana,

? investigation of methods for organic matter application and incorporation to steep slope areas (greater than 33 percent) through literature review and correspondence with equipment manufactures and contractors, and

? integration of this knowledge base into a proposal for Phase II of this project.

Phase II of the project is the subject of this proposal. The objectives of Phase II are to:

? construct test plots on steep highway cut slopes with erosive and/or poorly vegetated parent material;

? evaluate equipment and develop protocols for application and incorporation of compost on steep cut slopes;

? monitor and evaluate test plots on steep highway cut slopes; and

? communicate, report and provide technology transfer of the research findings

4.0 Benefits

Several potential benefits may result from completion of this research project. Direct cost savings to MDT may be realized through avoidance of maintenance costs. These costs may include removal of debris from roadways, removal of sediment from ditches and unplugging sediment clogged culverts. When roadbase saturation occurs as a consequence of plugged ditches, maintenance costs may include filling potholes and repaving disrupted asphalt surfaces. Repair costs may also be avoided when steep cut slopes require post-construction maintenance such as that occurring along U.S. Highway 2 west of Happy's Inn. At this location a single cut slope was covered with erosion control fabric in an attempt to decrease erosion at a cost in excess of $100,000. Significant erosion appears to persist on this slope despite the expenditure and effort.

The Montana Department of Environmental Quality (DEQ) Water Protection Bureau monitors sediment releases to surface water from construction sites in Montana. Releases from construction sites to waters of the State have been the trigger for tens of thousands of dollars in fines paid by MDT. Stable cut slopes will diminish the probability of citation for stormwater releases that can reach $25,000 per day for each violation.

Increased safety is an indirect benefit of this project. Rock fall and sediment flow from steep cut slopes onto the roadway is a safety concern for motorists through either impact with debris or loss of vehicle control. Increased water flow onto roadways and concurrent ice build-up is an additional consequence of drainage ditches plugged with sediment.

Improved service by MDT to the public will be enhanced by minimizing the labor and equipment hours committed to sediment control issues caused by eroding cut slopes, thereby allowing MDT Maintenance personnel more discretionary time to respond to service requests.

Improved procedures are envisioned as an outcome of this project by addressing long-term erosion concerns on steep slopes at the time of construction rather than after the fact when a problem results. Addition of compost to steep cut slopes could be readily integrated as a standard operating procedure in the revegetation design for all MDT construction projects.

All of these collective benefits cannot be accrued until the practicality and implementability of compost addition to steep cut slopes has been demonstrated and the proper amendment rates and procedures derived. This research project aims to serve as the basis for future decision making by MDT.

5.0 Research Plan

This research investigation will be conducted to develop a pragmatic technical basis for future MDT steep slope revegetation work based on principles developed by others as described in the Phase I Report literature review and by testing incorporation of compost which has not been tried in other states. It is well documented in literature and supplemented by many field examples that compost addition on the surface of disturbed soil on steep slopes results in enhanced vegetation establishment and development. The goal of this research investigation is to adapt existing knowledge of compost performance to the unique parent material and steep slope conditions encountered by MDT in select areas across the State. The resulting research findings will subsequently serve as the basis of design for future MDT steep slope revegetation work. Primary experimental variables to be evaluated in the study include vegetation and erosional conditions measured over the 3 growing seasons immediately following plot construction on plots comparing compost surface applications, compost incorporation and a control plot. Soil sampling will occur prior to and following plot construction to establish the physical and chemical characteristics of the research plots before and after construction.

5.1 Soil Sampling and Analysis

Basic soils data, including pH, electrical conductivity, sodium adsorption ratio (SAR), N, P and K, organic matter, C:N ratio, rock content, and soil textural class will be obtained from collection and analysis of 3 composite samples from each plot. These composite samples will consist of three 0 to 4 inch depth subsamples taken on a 10-foot radius. These data will indicate if substrate variables are likely to affect overall vegetation performance and if any notable difference in these parameters occurs between individual treatment plots which may have to be factored in evaluation of vegetation performance.

5.2 Vegetation Response Variables

Vegetation cover and data from the first growing season would likely be inconclusive as experience has shown treatment effects for these parameters are more clearly manifested during the second and following growing seasons, especially when native species predominate.

Response variables for assessing vegetation performance for each treatment plot will be seedling establishment and seedling density during the first growing season; and plant canopy cover (Daubenmire, 1968) for the second and third growing seasons. Plant canopy cover will be measured for each morphological class and total vegetative canopy cover encountered in the cover frame. Canopy cover will be determined using 20 x 50 centimeter Daubenmire frames at 10 predetermined transect stations within each treatment plot. Transects will be permanently located in each plot. Results will be quantitatively evaluated using descriptive statistics, analysis of variance, regression and other appropriate comparative methods.

5.3 Erosion Response Variables

Erosion on all plots will be qualitatively evaluated utilizing the Erosion Condition Classification, Montana Revised Method (Clark, 1980). Estimates of volume of eroded material deposited below treatment plots will be noted, but no quantitative attempt will be made to calculate actual sediment yields from treatment plots. Erosion will be monitored twice each year, once in early spring following snow melt, and at the time of vegetation monitoring. A site erosion evaluation may also be made following any extreme climatic events. Data collected from vegetation monitoring and from plot soil sample information will be used with the Revised Universal Soil Loss Equation (RUSLE) program to calculate sediment yields for each plot on an annual basis. All RUSLE program inputs except climatic data will be available from site sampling and monitoring data. Climate data will be extracted from NRCS or NOAA databases best suited to the experimental locations.

5.4 Experimental Design

Test plots will be constructed at the Happy's Inn and Colstrip South in accordance with the experimental design (Figure D1) and Standard Operating Procedures described below. Following completion of test plot construction, the plots will be monitored for a three year period beginning with the summer 2004 growing season. A draft final report will be prepared in October 2006 and submitted to MDT for review. Further description of each task is provided in the Implementation narrative below.

Figure D1. Proposed Experimental Treatments.

Site	Parent Material	Site Preparation	Compost Application Rate (in)	Incorporation Equipment	Treatment Name
Happy's Inn	Glacial Till	Regrading	0	NA	Control
Happy's Inn	Glacial Till	Regrading	1	Snow cat	Incorporation with Low Compost Rate
Happy's Inn	Glacial Till	Regrading	2	Snow cat	Incorporation with High Compost Rate
Happy's Inn	Glacial Till	Regrading	1	None	Compost Blanket with Low Rate
Happy's Inn	Glacial Till	Regrading	2	None	Compost Blanket with High Rate
Happy's Inn	Alluvial Rock	Chisel	0	NA	Control
Happy's Inn	Alluvial Rock	Chisel	1	Snow cat	Incorporation with Low Compost Rate
Happy's Inn	Alluvial Rock	Chisel	2	Snow cat	Incorporation with High Compost Rate
Happy's Inn	Alluvial Rock	Chisel	1	None	Compost Blanket with Low Rate
Happy's Inn	Alluvial Rock	Chisel	2	None	Compost Blanket with High Rate
Colstrip South	Tongue River Shale	Slope Construction	0	NA	Control
Colstrip South	Tongue River Shale	Slope Construction	1	Dozer	Incorporation with Low Compost Rate
Colstrip South	Tongue River Shale	Slope Construction	2	Dozer	Incorporation with High Compost Rate
Colstrip South	Tongue River Shale	Slope Construction	1	None	Compost Blanket with Low Rate
Colstrip South	Tongue River Shale	Slope Construction	2	None	Compost Blanket with High Rate

5.4.1 Design Logic and Relevant Experimental Factors

? **Compost Incorporation –** Compost *incorporation* into the soil on steep slopes appear to occur very infrequently across the United States. A near universal application of compost blankets has been applied to steep cut slopes. Compost is routinely incorporated into poor soil on slopes where agronomic equipment can be used. Few equipment options have been identified that are used to incorporate compost into steep cut slopes where conventional rubber tire agronomic equipment is unusable. Reclamation equipment capable of operating on steep slopes has been identified and is locally available. A modified snow cat has been used to perform various reclamation tasks on steep waste rock dumps at the Golden Sunlight and Zortman-Landusky Mines. The operator has extensive experience working on steep slopes and is confident that incorporation of compost can successfully be accomplished.

? **Incorporation Equipment –** Relatively few options exist for incorporation of compost on steep slopes. A number of potential options are available, but many have been deemphasized due to their local unavailability, cost or need for subsequent modifications. A modified snow cat is proposed for use at the Happy's Inn project site since this equipment is available and has a demonstrated track record. A dozer-based incorporation method is proposed for the Colstrip South project, since the contractor will be required to build the test plots and presumably will have a dozer available for the task. A contractor in California has been identified that uses a Caterpillar Challenger to both spread amendments and till steep slopes, but no local equivalent is known at this time.

The modified snow cat will have a standard agricultural 3-point hitch attachment. A tandem disk is proposed for incorporation work at the Mile Post 67 site, while a chisel plow is proposed at the Elk Creek Road site. Both of these implements will be attached to the 3-point hitch. A brush rake attachment for a crawler dozer is proposed for incorporation work at the Colstrip South site. The contractor should obtain a unit with close teeth spacing for this work, which may take more than one pass to adequately incorporate/mix the compost. Final selection of incorporation equipment will be the subject of Technical Panel input and contractor equipment availability.

One additional piece of equipment may be demonstrated at the Happy's Inn sites. The dealer for Terratrac tractors may provide one of these units for demonstration purposes.

All incorporation equipment utilized will be evaluated for capability of safe operation on steep slopes, production rates, the degree to which compost was mixed with substrate materials, and the control of tillage depth. These data will be necessary to select proper equipment for future work.

? **Compost Application Rates -** Application rates for compost addition are highly variable in the literature. Factors that influence the application rate include material cost, parent material characteristics and local experience with compost addition projects. The application rates typically vary between 0.5 and 6 inches with most projects averaging around 2 inches. Given the harshness of the sites selected it is our judgment that the 0.5-inch rate will have limited effect. In the experimental design we have suggested 2 application rates; surface application of 1 and 2 inch depths. It is estimated that the Happy's Inn project would require approximately 92 cubic yards of compost for the glacial till site and 46 cubic yards for the alluvial rock site using the current plot dimensions.

? **Compost Application on Slope** - Many potential methods of compost application onto steep slopes exist. Examples taken from the literature review suggest that blower trucks are almost always used to apply compost on steep slopes. A local contractor has recently purchased a blower truck, provided demonstrations to MDT personnel and expressed an interest in participating in the research project. The search for alternative methods for compost application has been terminated in favor of using this equipment for the project.

? **Compost Source –** Limited effort has been expended to evaluate differences between compost sources. We propose to use only those compost providers approved by DEQ. We will solicit bids for compost for the Happy's Inn Site, emphasizing those sources closest to the project.

? **Colstrip South** - This project has not yet been constructed. This project site was visited. A number of potential research slopes were identified. Final selection of a research site will be dependent on the characteristics of the cut slopes following construction and input from MDT staff.

? **Plot size –** Test plot size needs to be sufficiently large enough to accommodate the incorporation equipment selected for the project, but not so large as to increase cost disproportionately. After several internal discussions we propose to create test plots uniformly 50 feet in width and the entire length of the steep slope. The 50-foot width should accommodate the incorporation equipment adequately and minimize edge effects. Since we previously discounted the development of an experimental design with plot replication it is reasonably necessary to have enough plot area to collect multiple vegetation measurements. A run-on control ditch or BMP will be constructed at the crest of each experimental plot to eliminate run-on. Any disturbed/unvegetated soil above the experimental plot will be treated to promote vegetation establishment, but will not be included as part of the experimental plot for evaluation.

? **Plot Dimensions (full length of slope)**

Happy's Inn Glacial Till

Plot length = ~100 feet
Individual plot width = 50 feet
Regraded slope steepness = ~2:1

Happy's Inn Alluvial Rock

Plot length = ~50 feet
Individual plot width = 50 feet
Regraded slope steepness = ~2:1

Colstrip South Shale

Plot length = ~200 feet
Individual plot width = 50
Constructed slope steepness = 2:1

? **Number of Experimental Replications**
N=1

? **Compost Application**
Blower Truck (Quality Landscaping, Belgrade, MT)

? **Compost Incorporation**
A modified snow cat with a standard agricultural 3 point hitch attachment will use a tandem disk for amendment incorporation at the Mile Post 67 site, while a chisel plow is proposed at the Elk Creek Road site. A brush rake attachment for a crawler dozer is proposed for compost incorporation at the Colstrip South site.

? **Seed Mix Selection**
Per Phil Johnson

? **Seeding Method**
Surficial Application—Dry Broadcast
Exception—On the compost blanket plots 50% of the seed will be applied with the blanket in the compost, the remaining 50% will be surface broadcast.

? **Surface Mulch Application**
None other than compost blanket experimental treatments

? **Standard Operating Procedures**
All plots will be ripped, chisel plowed or manipulated to loosen the top 6" (min)
No fertilizer will be applied
No mulch will be applied
Organic amendment target incorporation depth = 4 inches
Plots will be constructed late summer-Fall 2003
Plots will be seeded Fall 2003

5.5 Evaluation Criteria

The effectiveness of experimental treatments constructed in the field will be compared to a control plot established at the same time. No statutory guideline is available to define the required vegetation cover resulting from treatment, nor is a statutory guideline available to define unacceptable levels of erosion from the slope. Therein, objective evaluation criteria are not available. Statistical evaluation will provide an interpretation of the degree to which the treatments are different than the control, but overall treatment performance, whether acceptable or unacceptable, will be a management decision made by MDT.

Control plots will be prepared using the Standard Operating Procedures of the Montana Department of Transportation (MDT) for revegetation of cut slopes. This procedure entails preparation of the slope by regrading to the design steepness followed by seeding within 24 hours of completion with an approved seed mix.

6.0 Products

The product of this research investigation is the intellectual knowledge gained by MDT in the establishment of vegetation and control of erosion on steep cut slopes through amendment with compost. The Final Report will summarize these research findings and serve as the record of accomplishment, data collected and resultant interpretations. Supporting the Final Report will be numerous digital images and digital video showing construction of the test plots with innovative equipment and monitoring observations related to erosion and vegetation development. These products will be made available to MDT for use in training. Technology transfer will be coordinated between MDT and MSU to develop the most efficient and effective means of communicating the research findings to the target audience.

Quarterly Progress reports will be submitted in addition to a Draft Final Report. Submissions will be made electronically with the exception of the Final Report that will be submitted electronically and as a hard copy.

7.0 Implementation

Tasks A through E were principally completed during Phase I of the project and are reported in the Draft Phase I Report. Significant Phase I tasks were the literature review, equipment evaluation and field site reconnaissance. Tasks F through M described below relate to plot construction and monitoring. Budgets associated with each task are presented in section 13 of this proposal.

7.1 Task F Preconstruction Meeting

The scope of this task will be to attend one or more preconstruction meeting or meetings for the Colstrip South project. An initial meeting occurred June 23, 2003 that was not attended. The intent is to establish communication lines with both Montana Department of Transportation (MDT) project personnel and the contractor. MDT and contractor expectations for personnel working on site will be discussed. Meetings are expected to occur in Miles City.

7.2 Task G Construction Schedule Coordination

Interface with MDT and contractor to coordinate plot construction at site.

7.3 Task H Plot Construction

Construction oversight will be provided to ensure accurate and acceptable test plot implementation. This task will include staking plots, checking compost application depths, and compost incorporation effectiveness. Additionally, permanent photo points will be established and used to establish the pre-treatment and during treatment conditions. Plot sampling will also be completed during this time if possible.

7.4 Task I Site Sampling

This task will consist of collection of composite samples from research plots and one composite sample of the compost as delivered to site. Soil sample collection will occur immediately following plot staking and prior to compost addition. The soil samples will provide data characterizing the pre-treatment condition. The OM content will be measured in the soil following construction. Post-construction soil sampling will be limited to the top 4 inches of soil, and will occur during Year 2 monitoring to allow time for settling.

7.5 Task J Year 1 Monitoring

The Year One vegetation monitoring will be limited to data collection for seedling density and emergence. Erosion will be monitored in the early spring and at the time of vegetation evaluation.

7.6 Task K Year 2 Monitoring

The Year Two vegetation monitoring will include cover measurement by species and production by morphological class. Erosion will be monitored in the early spring and at the time of vegetation evaluation.

7.7 Task L Year 3 Monitoring

The Year Three vegetation monitoring will include cover measurement by species and production by morphological class. Erosion will be monitored in early spring and at the time of vegetation evaluation.

7.8 Task M Reporting

The scope of this task will be to prepare 12 quarterly reports, a draft final report, and the final report following MDT's review of the draft final. Quarterly reports will include results of monitoring (vegetation and erosion) of previous quarter. The project findings will be presented to MDT at a meeting in Helena.

A total of 12 quarterly reports, one draft final report, and the final report are anticipated. A Power Point presentation of study findings and recommendations for application and incorporation of compost will be presented in a format suitable for contractors and MDT personnel.

8.0 Time Schedule

Table D1. Schedule for Phase II of the project for both the Happy's Inn and Colstrip South Projects.

				April 2003	May 2003	June 2003	July 2003	Aug 2003	Sept 2003	Oct 2003	Nov 2003	Dec 2003
Preconstruction Meeting, Task F								■	■			
Construction Schedule Coordination, Task G								■	■			
Sampling and Analysis Plan Development, Task I								■				
Quarterly Report 1, Task M										■		
Plot Construction, Task H									■	■		
Site Sampling< Task I									■	■		
Compost incorporation depth evaluation, Task H									■	■		
Site Seeding, Task H										■		
	Jan 2004	Feb 2004	March 2004	April 2004	May 2004	June 2004	July 2004	Aug 2004	Sept 2004	Oct 2004	Nov 2004	Dec 2004
Quarterly Report 2, Task M	■											
Spring Erosion Evaluation, Task J			■	■								
Quarterly Report 3, Task M				■								
Quarterly Report 4, Task M							■					
Year 1 Vegetation Monitoring, Task J							■	■				
Quarterly Report 5, Task M										■		
	Jan 2005	Feb 2005	March 2005	April 2005	May 2005	June 2005	July 2005	Aug 2005	Sept 2005	Oct 2005	Nov 2005	Dec 2005
Quarterly Report 6, Task M	■											
Spring Erosion Evaluation, Task K			■	■								
Quarterly Report 7, Task M				■								
Quarterly Report 8, Task M							■					
Year 2 Vegetation Monitoring, Task K							■	■				
Quarterly Report 9, Task M										■		
												■
	Jan 2006	Feb 2006	March 2006	April 2006	May 2006	June 2006	July 2006	Aug 2006	Sept 2006	Oct 2006	Nov 2006	Dec 2006
Quarterly Report 10, Task M	■											
Spring Erosion Evaluation, Task L			■	■								
Quarterly Report 11, Task M				■								
Quarterly Report 12, Task M							■					
Year 3 Vegetation Monitoring, Task L							■	■				
Draft Final Report, Task M										■		
Final Report, Task M												■

9.0 Staffing

Pertinent background information for team members, research experience and accomplishments were provided in the Phase I proposal and are not repeated.

Current commitments to other work performed by the Reclamation Research Unit currently involves 11 active projects with closing dates as early as 6/30/03 and as late as 9/30/05. Many of the projects are continuation projects with undefined future work tasks. Therein, a detailed analysis of staffing commitments in the future is not possible. Given the comparatively small scope of work required by this project as a percentage of total yearly work hours (typically <15%) (Table D2), no difficulty is expected in accommodating the budgeted workload. The predominant distribution of work hours is front-end loaded with plot construction during fall 2003. This workload is anticipated in 2003. Yearly commitments of hours for monitoring during 2004-2006 are less significant. No substantial deviation in the level of effort proposed for principal and professional members of the research team will be made without concurrence of MDT.

Table D2. Reclamation Research Unit staff hours committed to completion of this project. (See footnotes)

Personnel Name	Role in Study	Colstrip South		Happy's Inn		Total	
		Hours	% Year	Hours	% Year	Hours	% Year
Neuman	Research Director	128	2	172	3	300	4.8
Jennings	Principal Investigator	216	3	326	5	542	8.7
Goering	Research Associate	158	3	248	5	406	8.6
Blicker	Research Associate	126	2	234	4	360	5.7
Major	Field Technician/ Clerical	98	3	122	3	220	5.9

Explanatory Footnotes

Neuman, Jennings and Blicker are full time staff (1.0 FTE). Major (0.6 FTE) and Goering (0.75 FTE) are currently employed on part time appointments. Hourly estimates for % Year are based on respective Full Time Equivalent (FTE) appointment. The % Year calculation is based on 2088 hours annually (1.0 FTE) over the 3.5-year duration of the project. Since the Colstrip South and Happy's Inn projects are independently budgeted, the respective time commitment is reported in Table D2 rather than the yearly hours committed.

10.0 Facilities

Facilities necessary to complete the research are available for this project. Office facilities include computers, printers, telephones and conventional office equipment. Field equipment includes vehicles, digital cameras, GPS, hand tools and disposable products identified as line items in the budget. Contractors will accomplish heavy construction work. Purchase of additional equipment for field or office is not anticipated.

11.0 MDT Involvement

Successful completion of the proposed research will require the involvement of the Montana Department of Transportation at a number of different levels. Project management will be required to coordinate the participation of the project Technical Panel, to review and provide comments on reports, to facilitate test plot construction, to provide accounting support for grant administration and to participate in technology transfer upon completion of the research. MDT responsibilities for test plot construction are listed below.

Happy's Inn
Right-of-Way access agreement
Fencing removal permission (if required)
Permission to remove and relocate excess fill material
Loading and transportation of excess fill (MDT Maintenance Division)
Provide seed for plots
Traffic control

Colstrip South
Permission to conduct research
Coordination with MDT Project staff
Plot construction by contractor
Purchase of all materials by contractor
Traffic control

12.0 References

Clark, R. 1980. Erosion Condition Classification System. Determination of Soil Erosion Condition Montana Revised Method. U.S. Department of the Interior, Bureau of Land Management Technical Note #346.

Daubenmire, R. 1968. Plant Communities. Harper & Row, New York, NY. 300 p.

13.0 Budget Pages

Double click on the excel icon below to open up the budget spreadsheet. The spreadsheet is comprised of 19 pages beginning with the ‘tab’ labeled literature review. The total requested amount is $108,974.64 through December 2006. The total direct costs are $90,812.20. The indirect costs total $18,162.44.

Microsoft Excel
Budget Worksheet